



**Town of Arlington
730 Massachusetts Avenue
Arlington, MA 02476**

Artificial Turf Study Committee

Final Committee Report

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Introduction

Arlington has long been a draw for young families seeking to raise their children in a vibrant community convenient to Boston. The most recent United States Census data pegs Arlington's 18-and-under population at more than 1 in 5. Communities with large numbers of young people require the open spaces and playing fields that those young people want and need. In recent years, Arlington's supply of playing fields has struggled to keep up with the rising demand. Even when Arlington's fields have met that demand, it has not been without criticism. In particular, it is widely accepted that many of Arlington's playing fields are worn and tired, suffering from both overuse and weather limitations. The demand for Arlington's fields has moved in parallel with the deterioration of those fields.

Amidst this predicament, town residents have searched for solutions whereby the supply of quality playing fields could match the intense demand. It is within this context that the topic of artificial turf playing fields (also known as synthetic turf playing fields) has emerged. For those town residents seeking a way to maximize each playing field to meet the demand for those fields (particularly from youth sports leagues), artificial turf fields would appear to offer an attractive alternative. Artificial turf proponents argue that these fields are able to withstand New England weather while being versatile enough to maximize field playing time without sacrificing the quality of playing conditions.

Despite the benefits cited by proponents, others have raised concerns about the hazards of materials used to make artificial turf, the costs associated with installing and periodically replacing artificial turf fields, and the adverse health effects experienced by those who play on and use artificial turf fields. Opponents argue that the vaunted benefits of this playing surface cannot overcome its notable and distinct limitations.

Into this debate the Arlington Artificial Turf Study Committee (ATSC) entered in December 2023. Created by passage of Amended Article 12 at the 2023 Annual Town Meeting, the ATSC was charged with reviewing and reporting on "artificial turf: its health, safety, and environmental impacts, and potential mitigation measures, and a comparison of artificial turf to natural turf fields." Consisting of seven voting members and two non-voting members -- all of whom represent parts of town government with concerns about and interests in Arlington's playing fields -- the ATSC sought to provide information to town leaders and residents who see great potential in the use of artificial turf but have legitimate concerns about its health, safety, and environmental impacts. With an overarching commitment to take the proverbial "deep dive" into the subject matter, the ATSC has meticulously and diligently studied artificial turf without fear or favor, letting science and data dictate its questions and its studies.

This report is the product of those efforts.

Scope of Work

The ATSC was charged with examining health, safety, and environmental impacts related to the use of both artificial and natural grass turf fields, as well as potential mitigation measures. Consistent with that charge, the Committee focused its research and discussions on several

specific areas related to turf fields: access to youth sports and its impact on mental and physical health; heat impacts on human health and heat related injuries; heat impacts on the environment; skin/bacteria issues; injury rates; chemical impacts on human health and the environment; alternative infills; chemical and particulate runoff impacts; stormwater management impacts; climate change resilience impacts and ecological effects; and a cost comparison of artificial turf fields to natural grass fields.

Access to Youth Sports and its Impact on Mental and Physical Health

Research shows that exercise and team sports, in particular, improve the overall health of young people. According to the Science Board that works in the President's Council on Youth Fitness and Nutrition, participation in sports impacts many aspects of health. Equitable access to youth programs both promotes exercise and allows children to develop the social interactions that occur as part of a team. Exercise is linked to a reduced risk of many diseases including Type 2 diabetes, obesity, cancer, depression, and anxiety. When the national youth sports survey looked at who is not participating in sports, they found that Black, Indigenous, and People of Color (BIPOC) and low-income households were particularly impacted by access to sports. Lack of access to playing spaces is a key contributor to the problem. It is important to mention that Arlington's outdoor recreation spaces and youth sports programs are accessible to families that cannot afford private sports clubs. However, a lack of field space can impact both enrollment and access to practice and playing times.^{1 2}

New England weather complicates the lack of field space created by the high number of children enrolled in sports programs. The wet weather conditions limit access to grass fields during the busy season, March 15 - June 15 and August 15 - November 15. According to Arlington's Department of Recreation, there are many field closures for rain and resting periods after rain that require rescheduling of games and practice. Often, games can get played (or, on occasion, Arlington can move to an away site to make up a game), but there is little chance to make up practice. Artificial turf fields do not have to be closed for rain and they allow for continuous play and field use. Artificial turf can be used earlier and later in the season and potentially in winter months. According to Ian Lacy from Tom Irwin Advisors, an expert on both natural grass and artificial turf fields³, artificial turf fields can be used 1.3x-1.5x more than natural grass fields. However, this assumes a natural turf field is appropriately rested. In our current situation, Arlington does not appropriately rest its fields. So while conversion from natural grass to artificial turf may increase the days where practices and games can be held, it will not significantly increase the number of playing fields in the community.

It is important that Arlington youth can participate in youth sports and have access to playing surfaces that promote continuous play when adverse weather restricts play on natural grass fields. As such, Arlington should consider increasing playing spaces to ensure equitable access

¹ <https://health.gov/our-work/nutrition-physical-activity/national-youth-sports-strategy/questions-answers#q4>

² https://health.gov/sites/default/files/2020-09/YSS_ScienceBoardReport_2020.09.01_opt.pdf

³ <https://www.tomirwinadvisors.com/about-us/mission/>

to team sports for all its young residents.⁴ In addition, Arlington should consider some strategies for increasing the usability for existing fields. Some strategies may include:

- **Linear sand injection system⁵.** According to turf expert Ian Lacy of Tom Irwin Advisors, the installation of a linear sand injection system on a natural grass turf field is a mitigation strategy that may help to address flooding/moisture conditions and may be relatively inexpensive to install on existing fields.
- **Understanding the impact weather has on access to Arlington's existing playing fields.** To better understand how inclement weather affects Arlington's playing fields it would be beneficial to collect actual data as to when grass and artificial turf fields are closed due to weather conditions (rain, heat, etc.). Ideally, this data would be collected annually and could be used to compare one year to another.

An additional strategy is site specific installation of artificial turf, which holds the possibility of increasing access to youth sports programs in Arlington and usability of playing spaces for those programs. Although such a strategy may be beneficial to the overall health of Arlington's youth, there are notable downsides to artificial turf, which will be discussed in this report.

Heat Impacts on Human Health and Heat Related Injuries

The impact of heat on human sporting activities may become an increasingly important issue as we continue to see the warming effects of climate change. While some research casts doubt on an automatic relationship between air temperature and surface temperature, there is clearly cause for concern related to the heat effects of artificial turf fields on their users. Exposure to high heat levels, on all types of playing surfaces (including natural grass); can have a cumulative effect on the human body. Children in particular are more vulnerable to high temperatures than adults, and they are not as adaptable to changes in temperature as adults are. Additionally, children are less likely to accurately assess the degree of heat strain to which they are exposed, and therefore their desire to participate and compete may lead them to stay on the field despite a level of discomfort that might lead an adult to rest instead.⁶ For these reasons, it is important to look at how heat may affect a field user on both artificial turf and natural grass fields and determine what mitigation measures may be necessary during periods of high heat temperatures.

⁴ Accessibility is a concern for the community, and a main concern of the Massachusetts Architectural Access Board is "the ability of children with disabilities and parent and friends, to do the same things as abled bodied people do." See <https://www.mass.gov/doc/aab-minutes-41218>. Within Arlington's public recreation programs and facilities, there is support for diversity, equity, and inclusion, and the Town has undergone a self-evaluation process to help guide its improvement efforts toward those objectives.

See <https://www.arlingtonma.gov/home/showpublisheddocument/40400/636479962772100000>.

To be considered an accessible surface, ground surfaces need to be "stable, firm, slip resistant, and maintained with materials that ensure continued slip resistance." See <https://www.mass.gov/doc/521-cmr-2900-floor-surfaces-2006-pdf/download>.

Grass, like some other ground surfaces, may be problematic in that regard.

⁵ Sand injection is fundamentally similar to regular aeration, with the key difference being that sand injection uses a pressurized water system to inject the aeration holes with compact sand in real time, as the holes are being punched.

⁶ <https://www.scientificamerican.com/article/heat-waves-affect-children-more-severely/>

Numerous studies have documented extremely high surface temperatures on artificial turf, and while there has been limited research on the temperature of the air above the field, data indicates that players on artificial turf fields have higher skin temperatures, indicating greater heat load, and perceive a greater degree of heat stress than when on natural grass fields. Most reputable studies or analyses show that artificial turf fields with crumb rubber infill can get considerably hotter than natural grass on hot, sunny days. While natural grass fields rarely get above 100° F due to the release and evaporation of water vapor that leads to cooling, artificial turf fields, in comparison, regularly rise above 100° F.⁷ Penn State University's Center for Sports Surface Research conducted studies comparing surface temperatures of synthetic turfs composed of various fiber and infill colors/materials and found that the maximum surface temperatures during hot, sunny conditions averaged from 140° F to 170° F.⁸ Another study conducted at Brigham Young University found that the surface temperature of the synthetic turf was 37° F higher than asphalt and 86.5° F hotter than natural turf.⁹ This is a concern for many reasons, including, as neuroscientist Kathleen Michels points out: "Any temperature over 120° F can cause skin burns with skin contact in two seconds."¹⁰ In addition, research on heat stress in college athletes has shown that a significant heat exposure on one day can result in additional physiological stress days later.^{11 12} However, it should be noted that the most extreme heat issues related to artificial turf fields have usually been documented in regions of the country where air temperatures are regularly above 80°, not New England.¹³

When examining heat issues related to turf, measuring surface temperatures of natural and artificial turf fields may not be the best assessment of how the playing surface feels to the user. A more common quantification is Wet Bulb Globe Temperature (WBGT), which measures the "expected heat stress on the human body when in direct sunlight."¹⁴ WBGT is utilized by the military, the Occupational Safety and Health Administration, and the American College of Sports Medicine, and it is often viewed as the "gold standard" for measuring heat stress during hot weather and for creating heat-related safety standards.^{15 16} Arlington High School Athletics Department staff use WBGT when taking temperature readings on both artificial turf and natural grass fields. When doing so, they have found the playing environment to be between seven and ten degrees hotter on synthetic fields than on natural grass fields.¹⁷

Heat-related concerns over artificial turf fields in New England would be most acute in the hottest months of the year, namely June, July, and August (also known as meteorological

⁷ <https://www.nrpa.org/parks-recreation-magazine/2019/may/synthetic-sports-fields-and-the-heat-island-effect/>

⁸ Ibid.

⁹ Ibid.

¹⁰ Ibid.

¹¹ <https://plantscience.psu.edu/research/centers/ssrc/documents/temperature.pdf>

¹² <https://www.scientificamerican.com/article/heat-waves-affect-children-more-severely/>

¹³ <https://ftw.usatoday.com/2015/08/its-so-hot-in-texas-turf-is-melting-cleats>

¹⁴ National Weather Service. "Wet Bulb Globe Temperature: How and when to use it."

<https://www.weather.gov/news/211009-WBGT>

¹⁵ National Weather Service. "Wet Bulb Globe Temperature Informational Guide."

<https://www.weather.gov/media/safety/heat/2020-WBGT-Handout.pdf>

¹⁶ Cates J, Rheeling, J. "Wet Bulb Globe Temperature (WBGT) – Why Should Your School Be Using It?" National Federation of State High School Associations. Apr 2023. <https://www.nfhs.org/articles/wet-bulb-globe-temperature-wbgt-why-should-your-school-be-using-it/>

¹⁷ Presentation by Arlington High School Athletic Trainer Samantha Jones 2/13/24

summer). Fortunately for the Town of Arlington, there are few organized athletic uses of Arlington fields during that time period, meaning far less concern with heat stress or heat exhaustion on athletes. Arlington's town and school athletic fields receive their greatest use in the "shoulder seasons" of spring (April-May) and fall (September-November), where temperatures in Arlington do not regularly cross the 80° F mark. Climate change is raising temperatures, there will be more hot days even in the shoulder seasons, and surface temperatures on artificial turf fields in Arlington could reach very high levels even on more temperate days. There is a greater possibility that heat will be a concern in the future and therefore it must be addressed. But, unlike some other issues related to artificial turf fields, the heat-related concerns are very capable of being mitigated, especially in a community like Arlington that is in the New England climate.

One mitigation strategy used by some artificial turf field owners is to water the fields to keep them cool on hot days. Such a strategy is not recommended. Watering artificial turf fields is effective only for a short period of time, and temperatures usually rebound after only about 20 minutes. Moreover, adding irrigation to this type of sports field is costly and, depending on the type of infill used, could be ineffective, as water could simply roll off the surface and not really soak in to provide that small window of temperature relief.

There are, however, several mitigation strategies that could improve heat safety for field users and can be deployed either singularly or in combination with other strategies.

- **Using alternative infill materials on synthetic turf fields.** Alternative infill materials (sand, coated sand, cork, Brockfill, etc.) have been suggested as replacements to crumb rubber that are not only less toxic but may also result in cooler field surface temperatures.¹⁸ However, none of these alternative infills can provide a surface that is comparable in temperature to natural grass, and they may have other limitations, such as increased migration from the field or the need for more frequent maintenance and/or replacement. Information from the Penn State Sports Surface Research Center suggests that significant temperature reductions may not be possible with infill changes alone.¹⁹
- **Installation of signage on playing fields.** Often signage around fields includes warnings about damage to the turf field, but additional signage or an alteration to existing signage should alert users to the health risks associated with field use on very hot, sunny days.
- **Formalized education and training about heat safety for youth sports coaches.** Annual training on recognizing heat strain is provided to coaching staff as part of Arlington High School's Athletics Department's Emergency Action Plan. Additionally, a five-day acclimatization program has been implemented for football players whose exposure tends to be greater due to their use of pads and uniforms, in accordance with Massachusetts Interscholastic Athletic Association (MIAA) guidelines.²⁰ However, for non-high school sports organizations, it is unclear what type of training, if any, is

¹⁸ Presentation by Ian Lacy, Lead Project Advisor, Tom Irwin Advisors on 2/20/24.

<https://www.arlingtonma.gov/home/showpublisheddocument/68878/638442810992730000>

¹⁹ <https://read.dmtmag.com/i/32290-june-2011/19?>

²⁰ Presentation by Arlington High School Athletic Trainer Samantha Jones 2/13/24.

provided or required for volunteer coaches/parents in regard to recognizing and responding to heat strain events. Aside from high school events, it is unclear that there is consistent monitoring of field temperatures in the Town of Arlington.

- **Installation of shade cover at all playing fields.** During the design of field renovations, consideration should be given to the installation of shade structures that can protect the user from direct sunlight during resting periods. Such structures may include dugout covers and shaded sideline seating. This should be considered regardless of field type, as hot temperatures outside the summer season are becoming increasingly common.
- **Monitoring air and surface temperatures.** The Arlington High School Athletics Department currently monitors field temperatures (WBGT) during the hottest part of the year and has guidelines for when field use is safe. Practices and tryouts are scheduled for cooler parts of the day whenever possible. However, it is unclear whether there is consistent monitoring of field temperatures outside of high school athletics. As such, it would seem appropriate to establish an air and surface temperature monitoring program for synthetic turf fields during the hottest part of the year. Such a policy is not unheard of and, in some circumstances, is quite common. For example, local beach administrators (like the Massachusetts Department of Conservation and Recreation and the Arlington Board of Health) regularly monitor local beaches for elevated bacteria levels in the water; if the bacteria levels go above a certain level on a certain day, the authorities close the beach for that day. The MIAA has established guidelines for the use of athletic fields of any kind during hot temperatures, with the guidelines stating that there should be no use of fields when the wet-bulb temperature goes above 86.1° F. In the same way, it seems both logical and prudent for local officials (like the Department of Park and Recreation or School Department) to monitor air and surface temperatures at artificial turf fields (as well as other fields) in Arlington, especially during June-August; if surface temperatures go above a certain established level, then those fields would be closed to use for that day – much like natural grass fields are closed when rain or snow conditions prevent their use.

As an example, the Montgomery County Public Schools in Maryland has developed the following guidelines for use of its artificial turf fields:

- Anytime the outdoor temperature exceeds 80 degrees, coaches exercise caution in conducting activities on artificial turf fields.
- When outdoor temperatures exceed 90 degrees, coaches may hold one regular morning or evening practice (before noon or after 5 p.m.).
- When the heat index is between 91–104 degrees between the hours of noon and 5 p.m., school athletic activities are restricted on artificial turf fields to one hour, with water breaks every 20 minutes.²¹

²¹ <https://www.nrpa.org/parks-recreation-magazine/2019/may/synthetic-sports-fields-and-the-heat-island-effect/>

Heat Impacts on the Environment

It has been established that artificial turf fields are hotter than natural turf fields.²² But the excess heat generated by artificial turf fields has impacts on the environment beyond those on the human body.

The surfaces of artificial turf fields have been shown to be significantly hotter than natural turf fields, contributing to the urban heat island effect.²³ It is expected that climate change will add 13 to 23 days where temperatures exceed 90° F, an increase from the current 8 days per year in Arlington.²⁴ Artificial turf fields could exacerbate already increasing temperatures in Arlington, particularly in areas identified as heat islands.

The Metropolitan Area Planning Council performed a heat analysis to ascertain the areas of Arlington that are most at risk of extreme heat.²⁵ The hottest 5% of areas, or “hot spots,” generally follow the Massachusetts Avenue corridor, which is the most densely developed part of Arlington with the greatest amount of impervious surfaces. There are also “hot spots” in parts of East Arlington, in a relatively dense residential area north and west of Massachusetts Avenue. It seems advisable, to the extent practicable, to avoid installing artificial turf fields in or near the existing hottest 5% areas in Arlington.

In addition to creating heat islands, extreme heat can inhibit wildlife movement and disrupt ecosystems. Higher surface heat temperatures on artificial turf could inhibit any wildlife movement across those fields during the hottest days of the year. Furthermore, extreme surface heat may affect the temperature of any stormwater runoff, which can also affect the ecology of the aquatic environments that are the receiving waters of the runoff.

Skin/Bacteria

Beyond the obvious impact from extreme surface temperatures on artificial turf fields, such as heat stroke, are other effects relating to an individual’s skin.

Safe Healthy Playing Fields Inc. estimates that skin injury can result from contact with a surface lasting just several seconds when the heat index runs from 120° – 140° F.²⁶ Although that is a serious concern for users of artificial turf fields, there are obvious mitigation measures to address them. For example, it seems unlikely that someone using an artificial turf field is directly exposing their bare feet or skin to the surface for extended periods of time; moreover, signage can make clear that all users of the field must wear shoes at all times. And, as discussed earlier, there is no reason why the Town of Arlington, were it to have new artificial turf fields, could not limit or close the fields to use on the hottest days of the year.

²² https://www.turi.org/content/download/13271/203906/file/Factsheet.Artificial_Turf.September2020.pdf.pdf

²³ Ibid.

²⁴ <https://www.arlingtonma.gov/home/showpublisheddocument/51627/637268071185670000>

²⁵ Ibid.

²⁶ <https://www.safehealthyplayingfields.org/heat-levels-synthetic-turf>

Artificial turf fields also raise questions of bacterial infections. The Massachusetts Department of Public Health (DPH) addressed this issue directly:

Some studies have measured the levels of bacteria on surfaces of different types of athletic fields. Very limited research has found fewer bacteria in [artificial turf fields] ATF than soil and the federal study reported indoor ATF having fewer bacteria than outdoor ATF. However, many factors (e.g., presence of bacteria, moisture, and temperature) influence the risk of bacterial infections following the use of any athletic surface. The frequency and severity of skin abrasions can also influence the risk of infection. California's Environmental Protection Agency reported that athletes experience more frequent turf burns (i.e., skin abrasions) on ATF relative to natural fields. Overall, practicing good hygiene is the best way to prevent getting and spreading infections. Washing skin abrasions with soap and water can decrease the risk of bacterial infections.

²⁷

As noted by DPH, the threat of bacterial infections from artificial turf is real but limited, and it can be mitigated through good hygiene practices. For this reason, the Mount Sinai Children's Environmental Health Center similarly recommends that those who play on artificial turf surfaces wash their hands before eating, drinking, or adjusting mouth guards, as well as cleaning cuts and abrasions immediately.²⁸

Injury Rates

A long-running critique of artificial turf playing fields holds that they have a higher incidence of player injuries than natural grass fields. That was certainly true with the first generation of artificial playing surface known as AstroTurf. Physicians and trainers noted that players were injured with a greater frequency on that turf, including ACL tears, concussions²⁹, and ankle sprains.³⁰ In 1992, John Powell from the University of Iowa published a paper that showed that professional football teams had more major knee injuries on artificial turf when compared to professionally maintained natural grass.³¹ In that era, players complained of greater muscle soreness on artificial turf as compared to playing on a professionally maintained natural grass surface.³²

But artificial turf has advanced considerably from its early AstroTurf days, and that includes improvements in lowering player injuries. Artificial turf manufacturers have made advancements in simulating more natural surfaces, particularly with the use of crumb rubber infill mixed with sand, often giving the turf a more grass-like feel. Nevertheless, criticism of artificial turf as it relates to player injuries remains, and it is not uncommon to hear players

²⁷ <https://www.mass.gov/info-details/artificial-turf-fields>

²⁸ <https://static1.squarespace.com/static/57fe8750d482e926d718f65a/t/593b15421e5b6c414467a03b/1497044293003/CEHC+Position+Statement+on+Recycled+Rubber+Turf+Surfaces+2017-5-10.pdf>

²⁹ https://www.hss.edu/condition-list_concussion.asp

³⁰ https://www.hss.edu/conditions_high-ankle-sprain-whats-different.asp

³¹ https://www.hss.edu/conditions_artificial-turf-sports-injury-prevention.asp

³² https://www.hss.edu/conditions_artificial-turf-sports-injury-prevention.asp

vocalize their opinions about the difference between the playability of artificial turf versus natural grass.³³

Recent studies on player injuries provide a mixed picture. While some studies still see a greater likelihood of sports injuries with artificial turf over grass, other studies see the two playing surfaces as equivalent with respect to injuries, and one recent study even saw an advantage to artificial turf fields.³⁴

A 2023 review of research related to player injuries found that there is a higher rate of foot and ankle injuries on artificial turf, both old-generation and new-generation, compared with natural grass.³⁵ That review also noted that high-quality studies suggest that the rates of knee injuries and hip injuries are similar between playing surfaces, although elite-level football athletes may be more predisposed to knee injuries on artificial turf compared with natural grass.³⁶

In contrast, a 2022 study found that in a comparison of artificial turf to natural grass, injury rates were equivalent in most cases.³⁷ A notable exception to that finding was higher rates of foot and ankle injuries in general, as well as higher knee injury rates among elite-level American football athletes, on artificial turf playing surfaces.³⁸ But the study found that concussion rates on artificial turf are decreased compared to natural grass that is maintained by professional groundskeeping operations.³⁹

And, as previously noted, a 2023 study of football (soccer) players actually found the overall incidence of football injuries to be lower on artificial turf than on grass.⁴⁰

In light of recent studies and research, it seems hard to definitively say whether modern artificial turf playing fields inherently present more risk of player injury than natural grass fields that are maintained to a professional standard. There could be a slightly higher risk of foot and ankle injuries on artificial turf fields versus natural grass fields, but the difference is not dramatic. And there is some indication that, with respect to sports injuries, artificial turf playing surfaces might even be better than natural grass, including in the area of concussions. In the end, although there may be many important differences between artificial turf fields and natural grass fields, player injuries does not appear to be an area that stands out in that regard.

With the benefit of first-hand local experience on both natural grass and artificial turf with crumb rubber infill, Arlington High School's head athletic trainer, Samantha Jones, concurred with that assessment. She stated that she has not seen any measurable difference in the type or number of injuries associated with playing surface, noting that more frequent injury types are attributable to factors like differing physiology or player preparedness.

³³ https://www.hss.edu/conditions_artificial-turf-sports-injury-prevention.asp

³⁴ It should be noted that these studies were focused on professional and collegiate athletics, and very little study information is available about the casual or municipal user.

³⁵ <https://pubmed.ncbi.nlm.nih.gov/35593739/>

³⁶ Ibid.

³⁷ <https://www.intechopen.com/chapters/83186>

³⁸ Ibid.

³⁹ Ibid.

⁴⁰ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10139885/>

It is also worth noting that studies of sports injuries sometimes compare artificial turf fields to pristine, professional athletic natural grass fields. In that comparison, it is not surprising that the artificial turf fields often have a modestly worse record on certain sports injuries. But it is rare outside of collegiate or professional sports to find pristine, impeccably maintained natural grass fields. In reality, most municipal grass playing fields across the United States (like those in Arlington) are maintained to the level that is affordable for municipal budgets. Those fields are often stressed from heat and rain, and they can be much more likely to cause sports injuries.

Mark Cote, a Mass General Brigham Sports Medicine researcher who serves as director of Outcomes Research for Sports Medicine and Orthopedic Surgery at Massachusetts General Hospital, summed up succinctly the state of research on these issues in 2024: “I don’t think we’re at a point yet where we can say an injury would have been avoided because a field is turf or natural grass, nor are we at a point where we should immediately switch every field in America to natural grass.”⁴¹ Recognizing that artificial turf may increase the risk of non-contact injuries and that professional athletes often prefer natural grass playing fields, Cote stated: “While I’d prefer my own children to play on natural grass, I know an injury can happen on any surface without proper conditioning. At the end of the day, it’s a part of the sport.”⁴²

Chemical Impacts on Human Health

Artificial turf and its infills contain a wide variety of hazardous chemicals. What is not known at this point is how much exposure results from playing on these surfaces. In general, reducing exposure to hazardous materials has a positive health effect.

Exposure to hazardous materials comes in one of three ways: inhalation, ingestion, and dermal contact. While there is almost no data on the level of exposure to these materials in the context of artificial turf use, in general, when a product contains demonstrably toxic materials, minimizing possible exposure to them is always going to be better than not doing so. All things being equal, a reduction in potential exposure should lead to reduced harm to people and the environment.

Artificial turf fields in Arlington would be used primarily by children, who eat, drink, and breathe more per pound of body weight than do adults. As their brains and bodies are continually developing during childhood, the effects of any hazardous exposures are more significant than would be the case for comparable exposures in adults. For example, recent research suggests that there is no safe level of lead exposure for children. Their behavior also differs from that of adults, with more hand-to-mouth activity, which can act to increase potential exposures.

In terms of duration of exposure, almost all the exposure studies to date have been done on adults, who are less susceptible to comparable adverse exposure levels to chemicals. Many more children participate in youth sports programs than was the case 20 years ago, and as a result will likely have longer periods of exposure to any hazardous components in artificial turf than would

⁴¹ <https://www.massgeneralbrigham.org/en/about/newsroom/articles/turf-vs-grass-fields-sports-injury-prevention>

⁴² Ibid.

an adult. Exposure duration can be an important factor as diseases may have long latency periods (the time between exposure and disease).

Chemical exposure can lead to negative health outcomes. Chemical exposures can have cumulative impacts, defined as toxicity risk, carcinogenic risks, endocrine disruption risks, and reproductive risks. While there is an abundance of research that clearly illustrates the toxicity of components within artificial turf, there are few if any research studies that examine the potential for exposure to field users, nor do data currently exist that establish the exact level at which exposure to a particular hazardous material found in artificial turf results in disease. While one cancer related study suggested there was no association between artificial turf field use and cancer in athletes, there were questions raised about the methodology used in the study and whether or not the study results were valid.^{43 44 45}

There are also serious concerns related to crumb rubber infill and artificial turf fields. Crumb rubber infill, used to soften the playing surface on artificial turf fields, is made from very finely shredded automobile and truck tires, and has been one of the ways in which old tires are recycled. Used tires contain a wide assortment of toxic materials which have been linked to adverse human health effects and environmental damage. The small size of these particles makes it easier for dusts to be generated during field use, which can then be aerosolized and inhaled, or deposited on clothing or body parts. Dermal contact with these dusts or solids can result in an ingestion exposure if food is eaten without handwashing. In addition to potential direct exposures, these materials are a source of “take home” exposures if they are transferred via clothing, shoes, on skin, or in the hair to field users’ automobiles or homes. As such, the potential hazards associated with crumb rubber should be taken into consideration by Town officials when making decisions about future projects that may involve this material.

In addition to crumb rubber infill, artificial turf fields contain other chemicals of concern and hazardous materials, including the following:

Polycyclic aromatic hydrocarbons (PAHs). PAHs are chemicals that exist naturally in coal, oil, and gasoline. They can be formed by the burning of these materials, along with wood, tobacco, and even food that is cooked at high heat, such as meat on a grill. Exposures can result from breathing tiny PAH particles or particles to which PAHs are bound, eating grilled or charred food, or food onto which PAH particles have deposited from the air. Some PAHs can be absorbed through the skin. Exposures to PAHs have been associated with skin, lung, bladder, liver, and gastrointestinal cancers. High rates of cancer among firefighters are thought to be due to PAH exposures. Animal studies have shown an association between PAH exposure and reproductive, neurologic, and developmental effects.^{46 47}

⁴³ <https://kuow-prod.imgix.net/store/ee4a593cdd79b5f99ee947785173a309.pdf>

⁴⁴ <https://doh.wa.gov/community-and-environment/schools/environmental-health/synthetic-turf>

⁴⁵ <https://www.kuow.org/stories/does-playing-soccer-on-artificial-turf-increase-cancer-risk-especially-in-kids>

⁴⁶ <https://doi.org/10.1016/j.envpol.2022.119841>

⁴⁷ <https://doi.org/10.1016/j.envpol.2022.119841>

Heavy metals. Metals such as lead, zinc, and chromium as well as others, are commonly found in crumb rubber. These metals can have a range of adverse health effects, including impairment of the nervous system, gastrointestinal and kidney issues, immune system dysfunction, reproductive system toxicity, and cancer. Indications are that the primary route of field users' exposure to metals would be through ingestion rather than inhalation.⁴⁸

Per- and polyfluoroalkyl compounds (PFAS). PFAS is the umbrella term for the thousands of fluorinated compounds, which are commonly referred to as "forever chemicals" due to their extreme resistance to breaking down in the environment. They have been used in any number of products, including nonstick cookware, firefighting foam, stain-resistant upholstery, and rainwear. It has been estimated that nearly all Americans have been exposed to PFAS through drinking water contamination, using products made with PFAS, or breathing PFAS in the air. A number of these compounds have been banned for use in children's toys and other consumer products, and many manufacturers are trying to come up with safer alternatives. However, for other consumer products, including artificial turf, compliance with the ban is totally voluntary. New fluorinated compounds are continually being developed and used. Because there are many opportunities for exposure, and PFAS are resistant to breaking down, they can accumulate in our bodies. Data suggests that the amount of PFAS in our blood can be one thousand times greater than the EPA's proposed level for drinking water. Adverse health effects include alterations in metabolism, altered thyroid function, higher risk of being overweight, lower fetal growth rates, and reduced effectiveness of our immune system.^{49 50 51 52 53}

Phthalates are often referred to as plasticizers. They can make plastic products flexible and longer lasting. They are used in a wide variety of products including food packaging, medical products, personal care items, and sporting goods. The CDC states: "People are exposed to phthalates by eating and drinking foods that have contacted products containing phthalates. Some exposure can occur from breathing phthalate particles in the air. Children crawl around and touch many things, and then put their hands in their mouths. Because of that hand-to-mouth behavior, phthalate particles in dust might be a greater risk for children than for adults. Inside a person's body, phthalates are converted into breakdown products (metabolites) that quickly leave the body in urine. Research has documented a wide variety of adverse health effects resulting from chronic exposure to phthalates, including disruption of the endocrine system and abnormal functioning of some organ systems. This can affect pregnancy outcomes, child growth and development, and reproductive systems in both young children and adolescents."^{54 55 56 57 58}

⁴⁸ <https://www.nature.com/articles/s41598-023-38574-z>

⁴⁹ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10718084/>

⁵⁰ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6348874/>

⁵¹ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10423336/>

⁵² <https://factor.niehs.nih.gov/2022/10/science-highlights/pfas-liver-injury>

⁵³ <https://www.healthandenvironment.org/che-webinars/96609>

⁵⁴ <https://www.mdpi.com/2227-9032/9/5/603>

⁵⁵ <https://www.hsph.harvard.edu/news/features/the-big-3-why-phthalates-should-be-restricted-or-banned-from-consumer-products/>

Microplastics: Comparable to investigations into the human health effects of PFAS and phthalates, research on the health effects of microplastics in both aquatic species and humans is extremely limited and in its early stages. Exposure to microplastics occurs through inhalation, ingestion, and food consumption, and is an increasing worldwide concern. Research indicates that ingestion of microplastics is harmful to aquatic and animal species, resulting in inflammation, oxidative stress, and cytotoxicity among other adverse effects. Translocation of these tiny plastic particles has been found to occur in mice after ingestion, including passage through the blood-brain barrier. It is believed that these may be seen in humans as well. One study showed behavioral changes in mice following short-term microplastic exposures.⁵⁹ In addition to the plastic particles themselves, there are concerns about the toxicity of compounds that have been either added to or are adsorbed to the surface of the base plastic, such as colorants, phthalates, and other chemicals which are used to provide specific properties, or heavy metals, which could result in other harmful effects.^{60 61 62}

While the chemicals above are in the highest quantities in the crumb rubber, they also can exist in the grass blades. While nearly all Americans currently have some level of exposure to both PFAS and phthalates, virtually all of the papers addressing health issues around PFAS and phthalates in artificial turf acknowledge that there is inadequate research in terms of exposure, and that much more research is needed. For example, while there are standards for PFAS in drinking water, there are currently no definitive levels for PFAS or phthalates at which adverse health effects will occur, making it difficult to associate specific levels of exposure with disease.

An additional chemical that has recently been discovered in used tires is 6-PPD Quinone.

6-PPD is an antioxidant compound which is added to the rubber in automobile and truck tires to prevent cracking and early aging and to increase their lifespan. When exposed to ozone and oxygen it transforms into 6PPD-quinone, further discussed in the section “Chemical and Particulate Runoff Impacts” below.^{63 64}

The limitations of existing personal sampling equipment make collecting inhalation exposure information during actual play or other representative field activities extremely challenging. New methods for both sampling and analysis are continually being developed and will hopefully be able to shed additional light on this important topic in the future. There is a long history of chemicals being found to cause harm at levels well below that originally thought to be

⁵⁶ <https://doi.org/10.1016/j.cbpc.2023.109645>

⁵⁷ https://journals.lww.com/co-pediatrics/abstract/2013/04000/phthalate_exposure_and_children_s_health.16.aspx

⁵⁸ https://www.epa.gov/sites/default/files/2017-08/documents/phthalates_updates_live_file_508_0.pdf

⁵⁹ <https://www.mdpi.com/1422-0067/24/15/12308>

⁶⁰ <https://doi.org/10.1021/envhealth.3c00052>

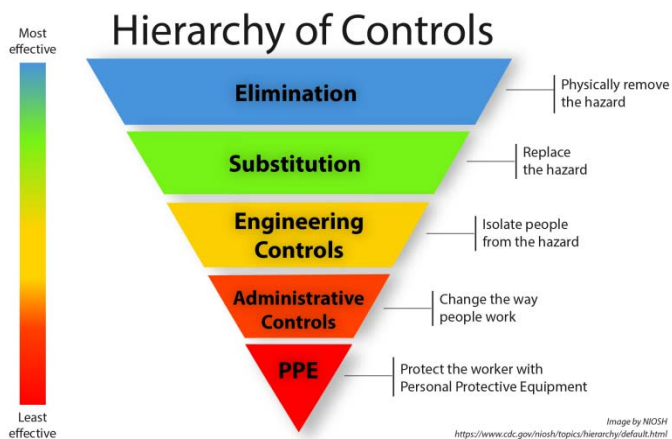
⁶¹ <https://particleandfibretotoxicology.biomedcentral.com/articles/10.1186/s12989-020-00387-7>

⁶² <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8800959/>

⁶³ <https://www.epa.gov/chemical-research/6ppd-quinone>

⁶⁴ <https://doi.org/10.1016/j.scitotenv.2023.165240>

problematic, and it is not unreasonable to ask whether people should voluntarily add to their existing exposure levels when it may not be absolutely necessary.



The use of less toxic materials will always be better than more toxic ones, even without exposure data, as that reduces the possibility of exposure to a toxin. This is the basis for the Occupational Safety and Health Administration's (OSHA) hierarchy of controls, which call for (in order of effectiveness) eliminating the hazardous material entirely, substituting safer chemicals for more hazardous ones, implementing engineering controls to capture emissions or guard against mechanical

hazards, administrative controls such as work practice changes, and finally using personal protective equipment as the final and least preferred alternative.⁶⁵

Based on the available research, it seems advisable to move away from crumb rubber infill. As to what alternative infill material is preferable, continued research will be necessary. A portion of the Toxics Use Reduction Institute (TURI) comparison of infill materials is shown below.

Category	Tire crumb	EPDM	Shoe materials ^a	TPE	Acrylic-coated sand	Mineral- or plant-based
Lead ^b	Present	Present	Present	Present	Below detection limit ^c	Absent in some cases
Zinc ^b	Present	Present	Present	Present	Present ^c	Present in some cases
Other metals ^b	Present	Present	Present	Present	One additional metal present ^c	Present
Vulcanization compounds ^d	Present	Present	Present	Generally absent	Expected to be absent	Zeolite, when present, poses serious respiratory hazard. Plant-based materials can pose concerns related to dust, fungi, or allergens. Vulcanization compounds and phthalates are expected to be absent; VOCs and PAHs are expected to be low or absent. ^h
Phthalates	Present ^e	Present (lower) ^f	May be present, but subject to RSL	Present ^e	Expected to be absent	
VOCs	Present ^e	Present (lower in some cases, higher in others) ^f	Expected to be present, but subject to RSL	Present (lower) ^e	Expected to be absent	
PAHs	Present ^e	Present (lower) ^f	May be present, but subject to RSL	Present (lower) ^e	Below detection limit ^c	
PAHs (TURI sample) ^j	Present (highest) (548 mg/kg)	Present (20 mg/kg)	Present (55 mg/kg)	Present (below 10 mg/kg)		

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⁶⁵ https://www.osha.gov/sites/default/files/Hierarchy_of_Controls_02.01.23_form_508_2.pdf

Aside from discontinuing use of crumb rubber infill, another recommended mitigation strategy could include pre-installation testing by an independent laboratory to ensure that the materials are PFAS-free -- since once they are installed, it can be difficult to determine if any PFAS present is from the field materials or from PFAS that is already in the environment.

Alternative Infills

The environmental impact of artificial turf infill, in particular tire crumb rubber, has been identified as an issue of concern.^{67 68 69} There are, however, alternative infills. According to TURI's comparative assessment of chemical contents associated with alternative infills:⁷⁰

No infill material was clearly free of concerns, but several are likely to be somewhat safer than tire crumb. Some alternative materials contain some of the same chemicals of concern as those found in tire crumb; however, they may contain a smaller number of these chemicals, and the chemicals may be present in lower quantities.

Recently, several Massachusetts towns such as Lexington, Milton, and Malden have specified alternative infills to help mitigate chemical pollution and increased surface temperatures from the artificial turf fields permitted. Although certain alternative infills such as Brockfill and Greensand may hold promise for being more environmentally friendly and generating less heat than crumb rubber infill, there is not sufficient peer-reviewed research data at this time to definitively endorse them. Nevertheless, given the early promise of these alternative infills, as well as the widely accepted negative data on crumb rubber infill, it seems that future artificial turf projects should be looking exclusively at working with these alternatives. As time goes by and more reliable data on alternative infills is available, the case for these alternatives should be bolstered considerably.

Chemical & Particulate Runoff Impacts on the Environment

One of the most significant concerns surrounding artificial turf fields is their impact on wetland resources and waterways. Artificial turf fields can act as sources of harmful chemicals, including PFAS, metals, polycyclic aromatic hydrocarbons (PAHs), and others identified under the "Chemical Impacts on Human Health" section of this report.^{71 72 73 74 75 76} The State Wetlands Protection Act and its regulations, along with Arlington's Town Bylaw and its regulations,

⁶⁶ https://www.turi.org/var/plain_site/storage/original/application/b9727dedf5860ae7e83e3226d058b7ee.pdf

⁶⁷ <https://www.epa.gov/chemical-research/july-2019-report-tire-crumb-rubber-characterization-0>

⁶⁸ <https://pubs.acs.org/doi/10.1021/acs.estlett.2c00050>

⁶⁹ https://www.turi.org/content/download/13271/203906/file/Factsheet.Artificial_Turf.September2020.pdf.pdf

⁷⁰ <https://journals.sagepub.com/doi/full/10.1177/1048291120906206>

⁷¹ <https://portal.ct.gov/-/media/DEEP/artificialturf/DEPArtificialTurfReportpdf.pdf>

⁷² <https://www.epa.gov/chemical-research/july-2019-report-tire-crumb-rubber-characterization-0>

⁷³ <https://journals.sagepub.com/doi/full/10.1177/1048291120906206>

⁷⁴ <https://www.turi.org/content/download/11980/188623/file/TURI+Report+2018-002+June+2019.+Athletic+Playing+Fields.pdf>

⁷⁵ https://www.turi.org/content/download/13271/203906/file/Factsheet.Artificial_Turf.September2020.pdf.pdf

⁷⁶ <https://doi.org/10.1016/j.cscee.2022.100280>

require the protection of a variety of wetlands. Wetlands serve many functions and values in the community. These include groundwater supply, flood control and storm damage prevention, prevention of pollution, wildlife protection, plant and wildlife habitat protection, and protection of the natural character or recreational values of the wetland resources. A table outlining the potential negative impacts of artificial turf fields on each protected wetland interest can be found below and a map showing the proximity of recreational facilities (existing athletic fields) to wetland resource areas is included in Appendix 1.

Wetlands Values Table		
Wetland Value / Interest	Artificial Turf Field Meets Wetland Value / Interest?	Possible Mitigation for Artificial Turf Field
Public or Private Water Supply	Not applicable	
Ground Water Supply	No	Engineered Green Infrastructure (e.g., Bioretention Cells) may reduce some chemicals and microplastics but more research required to support this mitigation strategy
Flood Control	No - impervious	engineer field design and controls
Erosion Control and Sedimentation Control	Maybe	engineer field design and controls
Storm Damage Prevention	Maybe	engineer field design and stormwater management
Prevention of Pollution	No	Engineered Green Infrastructure (e.g., Bioretention Cells) may reduce some chemicals and microplastics but more research required to support this mitigation strategy
Wildlife Protection	No	No mitigation available
Plant or Wildlife Habitat	No	No mitigation available
Aquatic Species and their habitats	No	Engineered Green Infrastructure (e.g., Bioretention Cells) may reduce some chemicals and some microplastics but more research required to support this mitigation strategy
Natural Character or recreational values of the wetland resources	No	No mitigation available
Climate Change Resilience [Section 32, Arlington Wetlands Regulations, March 2023]	No	Alternate infills may reduce some heat impacts; but no mitigation is available for loss of Carbon sequestration; Sustainability issues / fossil fuel use

Artificial turf fields can contaminate the natural environment through leaching, airborne dust, volatilization, and physical migration of artificial turf components. Elevated concentrations of PFAS have been shown to have adverse effects on aquatic organisms, and PFAS environmental impacts from artificial turf are under-studied, though part-per-trillion (ppt) levels have been shown to be harmful. Elevated concentrations of the PFAS compounds PFOA and PFOS in aquatic ecosystems can result in death of aquatic organisms and affect their growth and reproduction. PFAS has been shown to leach from artificial turf fields and components. Additionally, tire crumb rubber, which is an infill material for most artificial turf fields, contains a newly discovered compound called 6ppd-quinone, which is acutely toxic to some freshwater fish. These chemicals, individually and in combination, pose a potential hazard to wildlife, water quality, and aquatic organisms, with an overall negative impact on the environment. Furthermore, microplastic particles from infill and weathered grass blades can also enter waterways, causing additional harm.^{77 78} As observed in Arlington at the Arlington Catholic High School artificial turf field and referenced in Arlington's Conservation Commission submissions to the May 2, 2023, Artificial Turf Forum and the ATSC, the tire crumb rubber infill from the school's field has migrated toward the nearby brook and within the protected wetland resource area of Mill Brook.

Though there is recent scientific evidence of the potential to use bioretention cells to reduce 6ppd-quinone concentrations in stormwater runoff impacted from oxidized tires / tire crumb rubber⁷⁹, it is unclear if these systems could be scaled-up to provide stormwater mitigation for an 80,000 square foot athletic field. The European Union recently acknowledged the negative impact of tire crumb rubber infills as microplastic pollution and in September 2023 enacted a ban on the sale of products containing intentionally added microplastics – specifically including in this ban “granular artificial turf infill”.⁸⁰

Natural turf fields can act as a natural filter for chemical and particulate pollution. Artificial turf fields typically do not contain systems to mitigate the chemical and particulate contamination in stormwater infiltration or runoff.⁸¹ Artificial turf fields that border wetlands, waterways, and other sensitive areas and resources are of most concern. Other areas are also impacted by artificial turf fields, as some chemicals can be volatilized and others may cling to clothing, shoes, and equipment, migrating off the fields to surrounding areas. Any stormwater drainage from an artificial turf field will eventually reach a wetland within Arlington. This extends environmental concerns beyond immediate proximity to sensitive areas. A field that drains to the public stormwater system may leak contaminants into a wetland or waterway downstream.

It should be noted that concerns about chemical runoff may arise with respect to natural turf fields, as well. Neither the Town of Arlington nor the ATSC has tested the natural grass playing fields in Arlington for concentrations of various chemicals of concern, including PFAS and

⁷⁷ <https://journals.sagepub.com/doi/full/10.1177/1048291120906206>

⁷⁸ <https://www.turi.org/content/download/11980/188623/file/TURI+Report+2018-002+June+2019,+Athletic+Playing+Fields.pdf>

⁷⁹ <https://pubs.acs.org/doi/epdf/10.1021/acs.estlett.3c00203>

⁸⁰ <https://pubs.acs.org/doi/10.1021/acs.est.4c00047>

⁸¹ <https://www.sportsfieldmanagement.org/natural-grass-athletic-fields/>

phthalates. Existing natural turf fields may also contain some amounts of those chemicals. Further study in this area is suggested.

Stormwater Management Impacts

How stormwater is retained, infiltrated, or discharged is important to the consideration of the environmental impact of artificial turf fields. Perhaps the most critical issue in this regard is the permeability of the playing surface, since permeable surfaces provide better stormwater management by allowing precipitation to infiltrate into the soil, rather than running off into storm drains or detention basins. The ability to manage stormwater will become ever more important as precipitation events become more severe and more unpredictable with expected climate change impacts.

The Massachusetts Department of Environmental Protection (MassDEP) is considering officially classifying artificial turf fields as impermeable surfaces under the Wetlands Protection Act. This change, if finalized, would potentially affect the siting and maintenance of artificial turf fields. MassDEP's latest proposed revision from December 2023 would define impervious surface for the "purposes of stormwater management (310 CMR 10.05(6)(k)-(q))" as follows:

any surface that prevents or significantly impedes the infiltration of water into the underlying soil, including, but not limited to artificial turf, Compacted Gravel or Soil, roads, building rooftops, solar arrays, parking lots, Public Shared Use Paths, bicycle paths, and sidewalks paved with concrete, asphalt, or other similar materials.⁸²

The permeability of artificial turf fields is a subject of debate, with some sources stating that they can be made permeable with the proper design and maintenance, and others stating that as an artificially constructed field, they are difficult or impossible to make permeable. While artificial turf fields can certainly be designed to quickly drain stormwater off the field (in many cases, more effectively than natural grass fields), the stormwater generally drains to perimeter drains and then to a detention basin or some stormwater management system. Since artificial turf fields are typically constructed on top of another engineered surface (rather than directly on top of the underlying soil), the real question then becomes whether the stormwater drains to a permeable surface, which depends on the specific design of the field.

There are techniques and systems that can allow for the capture and storage of stormwater, which can then be allowed to infiltrate into the soil and/or be released more slowly into the stormwater system to avoid overwhelming the system and causing flooding. Currently, artificial turf fields impede infiltration of water into the underlying soil, although this may change in the future as better systems are developed for managing the stormwater and allowing for improved stormwater infiltration to occur.

At a baseline, natural grass fields are considered permeable because they consist of natural grass over soil (unless the subgrade of the field is more heavily engineered). However, it is important to recognize that maintaining true and effective permeability requires ongoing maintenance of the fields, including proper aeration and grooming. Without that maintenance, the dirt

⁸² <https://www.mass.gov/doc/310-cmr-1000-wetlands-proposed-revisions-redlinestrikeout/download>

underneath the playing surface can become highly compacted and will not function as effectively as a permeable surface. Even under these conditions, a natural turf field may remain more permeable than an artificial turf field, but the exact comparison will depend on the design and maintenance of the field. It is difficult to make general statements about the permeability and stormwater management performance of artificial turf and natural grass fields, because the statements are highly dependent on the design, construction, and maintenance of the individual field, along with other factors such as topography and adjacent land use.

Climate Change Resilience Impacts and Ecological Effects

Issues surrounding climate change resilience and adaptation are increasingly critical as it becomes clear that our climate is changing in real time and we need to adapt our natural and built environment to address the threats associated with climate change, including extreme heat and precipitation. MassDEP defines Climate Change Resilience in guidance documents as follows.

The capacity to prevent, withstand, respond to, adapt to, and/or recover from climate change impacts and to build the capability and ability of an area/site/system to minimize the adverse impacts of climate change.⁸³

Artificial turf fields are inconsistent with climate change resilience in that they do not minimize anticipated adverse effects and, in fact, can exacerbate climate impacts.

Arlington has long been a leader in climate change resilience and mitigation, meaning that the Town adopts strong policies to minimize greenhouse gas emissions. Leaving aside the carbon footprint associated with artificial turf field construction, installation, and disposal, there are also climate impacts from the change from grass to artificial turf fields. While natural turf fields offer some mitigation of greenhouse gas emissions, especially carbon dioxide, artificial turf fields offer none.⁸⁴ Carbon sequestration is the process of creating long term storage of carbon dioxide, either geologically or in terrestrial ecosystems such as forests, fields, and other natural carbon sinks.⁸⁵ Natural turf fields create an opportunity for carbon sequestration in the field grass and soil, particularly if the field is well maintained and not regularly disturbed or fully replaced (since the removal and replacement of the turf will likely result in the release of some of the sequestered carbon).⁸⁶ While the amount of carbon sequestration that is possible through a natural turf field is more limited than would be possible in an unbuilt naturally vegetated environment, there is still a meaningful amount of carbon sequestration.⁸⁷ In contrast, an artificial turf field is a fully artificial environment that does not provide any standalone opportunity for carbon sequestration.

In the context of climate change, one must also consider the sustainability of artificial turf field components. There is mixed data related to whether meaningful recycling of artificial turf fields

⁸³https://www.lspa.org/index.php?option=com_dailyplanetblog&view=entry&year=2022&month=10&day=06&id=376:lspa-climate-change-mcp-toolkit-available

⁸⁴<https://doi.org/10.1016/j.scitotenv.2022.159974>

⁸⁵<https://read.dmtmag.com/i/27931-april-2011/7?>

⁸⁶<https://acsess.onlinelibrary.wiley.com/doi/10.2134/agronj2002.9300>

⁸⁷<https://www.mass.gov/doc/healthy-soils-action-plan-2023/download>

is currently happening (or happening consistently) in the Northeastern United States. The recycling question is an important one, because artificial turf fields must be replaced every 8-10 years. The recurring need for replacement over the lifetime of an athletic field must be reconciled with principles of sustainability and the risks that disposed components will migrate off site and become contaminants. If not recycled, components will be landfilled, incinerated, or subject to chemical decomposition; all of these options have negative climate change impacts and do not represent recycling into new plastic products. The Synthetic Turf Council states that “the carbon footprint of a particular recycle/end-of-life option (such as trucking long distances) may be integrated into the decision-making process and lead responsible parties to invalidate such an option”.⁸⁸

Installation of artificial turf can also have ecological effects. Habitat loss in urban settings is a significant threat to biodiversity and ecosystem health, including the systems that humans rely on for our quality of living.⁸⁹ Artificial turf replaces habitats, leading to a loss of plant and animal species diversity in the area. The removal or diminishment of a hub in the natural network has consequences for the whole system.

Cost Comparison of Artificial Turf Fields to Natural Grass Fields

In addition to health, safety, and environmental concerns, another area that is relevant to this topic is the life cycle cost comparison between artificial and natural grass turf fields, which includes installation, maintenance, replacement, and disposal costs.

While there are many variables to such a cost comparison, a true estimate is not possible without assessing and considering the site-specific field conditions. Additional factors related to cost include the potential funding sources for construction/rebuilding recreational fields, the overall municipal budget for field maintenance, and the availability of Town staff to regularly perform field maintenance, as opposed to outsourcing all or parts of field maintenance to contracted landscaping companies.

As stated by Ian Lacy of Tom Irwin Advisors, “you can’t compare a natural turf field to an artificial turf field because they are completely different systems.”⁹⁰ Artificial turf fields are designed and highly engineered systems, whereas the majority of natural grass fields are indigenous fields that have been adapted over time into playing fields. While there are many benefits and limitations to both types of fields, there is no way to get the same level of usage from a natural grass field as from an artificial turf field, especially with New England’s weather. Additionally, it is very challenging to assess a dollar amount to the number of hours and days in which a playing field, either synthetic turf or natural grass, can be utilized. As such, it would seem that a variety of factors, in addition to cost, would need to be considered when choosing the surface and maintenance program of an athletic playing field. Some of these factors include, but should not be limited to, the location, usage, and existing conditions of the field. Prior to major renovations or construction of its fields, the Town of Arlington should consider the best and most

⁸⁸ <https://www.syntheticurfCouncil.org/page/guidelines>

⁸⁹ <https://www.ipbes.net/global-assessment>

⁹⁰ Presentation on 2/20/24 by Ian Lacy, Lead Project Advisor, Tom Irwin Advisors.

<https://www.arlingtonma.gov/home/showpublisheddocument/68878/638442810992730000>

cost effective playing surface given site-specific conditions through a comprehensive assessment by a professional/consultant with experience in construction and maintenance of athletic fields.

The two major sources of funding for park and playground projects in Arlington are the Capital Plan and funding from the Community Preservation Act (CPA). In recent years, the Town has also benefited from parks and playground funding through the American Rescue Plan Act, which was a one-time infusion of funding from the federal government and is largely expended. It should be noted that CPA funds are prohibited from use for the acquisition of artificial turf for athletic fields. Although communities may still use CPA funds for other aspects of a field project, non-CPA funds must be appropriated to acquire the artificial turf surface.⁹¹

The Committee reviewed a variety of resources to try and better understand the costs associated with construction and maintenance of natural grass and artificial turf fields. Because no two resources were completely consistent in detailing what specifically is included in the cost, as such, it is hard to know how accurate these comparisons are at this time. Those resources include but are not limited to the following: presented material from Ian Lacy of Tom Irwin Advisors; the Toxics Use Reduction Institute (TURI) document “Building an Organic Maintenance Program for Athletic Fields: Guidance from Experts and Experienced Communities”; the Turfgrass Resource Center document “Natural Grass and Artificial Turf: Separating Myths and Facts”; as well as the maintenance costs reported by the Town of Arlington and Arlington Public Schools. These comparisons include the costs for the field itself and do not include costs for other typical elements of a playing field, like bleachers, lighting, fencing, etc., or the soft costs for design and construction management.

Installation Costs (per field)		
Organization	Artificial Turf	Natural Grass Field
Tom Irwin Advisors ⁹²	\$1,000,000	\$400,000
Turf grass Resource Center ⁹³	\$850,000-\$1,000,000	\$50,000-\$600,000

- *Tom Irwin Advisors- costs are based on a soccer sized field used for high school/college play. A high school/college sized soccer field is 81,000 square feet or 1.86 acres.⁹⁴ Detailed information about what is included in the installation was not available.*
- *The Turfgrass Resource Center- costs are based on 85,000 square feet or 1.95 acres and compare several types of natural grass fields to that of artificial turf fields. The artificial turf field costs vary from basic to premium construction and account for a ground rubber infill. The cost of natural grass fields varies depending on the soil base conditions and the preparation needs.*

⁹¹ <https://www.communitypreservation.org/allowable-uses>

⁹² Presentation on 2/20/24 by Ian Lacy, Lead Project Advisor, Tom Irwin Advisors.

<https://www.arlingtonma.gov/home/showpublisheddocument/68878/638442810992730000>

⁹³ <https://www.saratogasod.com/wp-content/uploads/2018/02/NaturalGrassArtificialTurf.pdf>

⁹⁴ <https://jobsinfootball.com/blog/soccer-field-dimensions/>

Annual Field Maintenance Costs (per field)		
Organization	Artificial Turf Field	Natural Grass Field
Tom Irwin Advisors ⁹⁵	\$15,000	\$30,000
Turf grass Resource Center ⁹⁶	\$13,000-\$39,000	\$8,000-\$49,000
Town of Arlington	\$13,000	\$11,000-\$40,000

- *Tom Irwin Advisors: detailed information about what is included in the maintenance costs was not available.*
- *Turfgrass Resource Center*
 - *Artificial turf includes the following: painting/removal, top dressing/infill, brushing/sweeping, disinfecting/fabric softener, carper repairs (rips; joints), water cooling, and weeding.*
 - *Natural grass field includes the following: painting, top dressing (sand), dragging, fertilizers, pesticides, aeration, sod replacement, and irrigation.*
- *Town of Arlington*
 - *Natural grass field maintenance contract includes the following: Aeration 3x/year; slice/seeding 2x/year; over-seeding on wear areas 2x/year; fertilizing 4x/year; and soil testing 2x/year. This does not include mowing/trimming, painting, or irrigation costs.*
 - *Artificial turf field is the responsibility of the Public Schools. According to Arlington's Athletic Director, the current maintenance contract includes the following: 6 visits (2 decompaction visits and 4 grooming visits), minor seam repairs, GMAX testing, and line painting for lacrosse and field hockey.*

End of Life Costs (per field)		
Organization	Artificial Turf Field	Natural Grass Field
Tom Irwin Advisors ⁹⁷	\$665,000 (carpet replacement and disposal costs @ 10yrs)	\$150,000 (Resodding @ 10 years)
Turf grass Resource Center ⁹⁸	\$149,000-\$191,000*	

- *Tom Irwin Advisors: includes removal and replacement of carpet at 10 years. Information about transportation charges was not available.*
- *Turfgrass Resource Center: includes disposal of carpet.*
 - *Does not include carpet replacement, transportation, or landfill surcharges that disposal may incur.*

⁹⁵ Presentation on 2/20/24 by Ian Lacy, Lead Project Advisor, Tom Irwin Advisors.

<https://www.arlingtonma.gov/home/showpublisheddocument/68878/638442810992730000>

⁹⁶ <https://www.saratogasod.com/wp-content/uploads/2018/02/NaturalGrassArtificialTurf.pdf>

⁹⁷ Presentation on 2/20/24 by Ian Lacy, Lead Project Advisor, Tom Irwin Advisors.

<https://www.arlingtonma.gov/home/showpublisheddocument/68878/638442810992730000>

⁹⁸ <https://www.saratogasod.com/wp-content/uploads/2018/02/NaturalGrassArtificialTurf.pdf>

Importance of Field Maintenance

One major factor which contributes to the life expectancy and usability of both artificial and natural grass fields is the maintenance of these surfaces. Ian Lacy of Tom Irwin Advisors has referenced a study he conducted at the FIFA headquarters in Zurich, Switzerland, in which he and his colleagues analyzed the maintenance needs of artificial turf used by a soccer association for 10 hours/day over a one-year period. As a result, he and his colleagues created maintenance frequency charts for both synthetic and natural turf surfaces, which can be found in Appendix 2. While these charts are based on usage of 10 hours/day for 7 days/week, they are not suggesting Arlington's fields need a similar level of maintenance. However, to extend the life expectancy and usability of its fields, a maintenance schedule for Arlington's specific needs (based on field usage related to type of activity played and number of hours per day the field is used) should be considered, budgeted for, and adhered to. Lacy stressed that despite municipal budget limitations, ongoing maintenance frequencies and costs must be considered in the cost of the initial project.

Given the limited number of playing fields in Arlington, better maintenance alone will not increase the field usage among user groups. One major challenge is Arlington's densely populated community and lack of additional open space to construct new playing fields. Similarly, converting one or two existing grass fields to artificial turf will not increase the usage or allow for the expansion of new or current recreational programs, although it would allow for user groups to access the fields earlier and later in the shoulder seasons and for some practices and games to continue when rain occurs during the season, thereby reducing a backlog of makeup games/practices.

While the Committee did not evaluate the full scope of field maintenance or management options, the Town of Arlington has developed a Public Land Management Plan which outlines those options and advises on the treatment of lands, such as playing fields, and includes recommendations of best practices.⁹⁹ As such, the Public Land Management Plan could suggest pathways for considering what type(s) of chemicals and maintenance make the most sense once regular maintenance is achieved.

Findings and Recommendations

After extensive research and discussion, the members of the Artificial Turf Study Committee reached a consensus with respect to the use of artificial turf in Arlington. Although no one on the Committee supported a moratorium or ban on the construction of artificial turf fields in Arlington, Committee members expressed concern with some of the environmental and health shortcomings of the product. In particular, the materials used in the production of artificial turf raise concerns about the impact on its users and the natural environment, including possible chemical pollution in aquatic ecosystems, particulate and plastic pollution, and increased heat. Committee members noted other environmental shortcomings of artificial turf, including its lack of carbon sequestration, the use of fossil fuels in its production, subsequent environmental impacts due to its required replacement every 8-10 years, and inconsistent recycling at end-of-life.

⁹⁹ <https://www.arlingtonma.gov/Home/Components/News/News/11931/2651?community=development>

On the other side of the ledger, Committee members recognized the merits of artificial turf, none more important than its accessibility and durability even in harsh New England weather. Although there is great appeal to the concept of natural grass playing fields, the simple reality is that those fields do not allow for the same degree of use as artificial turf fields. This Committee recognizes that young people greatly benefit from usable playing fields. A natural grass field does not serve its purpose if it sits unusable in early spring and late fall due to weather damage or overuse. Particularly in the shoulder seasons of March-April and October-November, artificial turf fields offer far more extensive opportunities for use than their natural turf counterparts. Moreover, Committee members acknowledged that many of the health and environmental shortcomings of artificial turf can be mitigated by using non-plastic and non-crumb rubber infills – with natural, alternative infills offering great potential.

On the whole, the Committee saw the benefits and drawbacks of artificial turf fields and carefully evaluated them. While Committee members opposed a ban on future artificial turf construction in Arlington, they could not fully embrace the option either. The Committee believes that artificial turf should be an option for future field planners in Arlington, after careful evaluation of the practicality and feasibility of natural turf options.

To the extent that future field planners choose to seriously evaluate artificial turf as an option, the Committee feels strongly that the following points should be considered by those planners for all future projects¹⁰⁰:

- Crumb rubber infills should not be used in artificial turf fields in Arlington.
- Any artificial turf installed at an Arlington field should be certified by an independent lab (not just the manufacturer) as being free of PFAS and other toxic chemicals before shipment.
- Any artificial turf field (and, for that matter, any natural grass field in Arlington) should be held to strict heat standards on the hottest days of the year, meaning those fields should be closely monitored by a designated Town of Arlington official to ensure that the fields are closed when surface temperatures exceed a certain recognized threshold.
- Any decision about where to place an artificial turf field should consider if placement of the field is in or near a designated heat island in Arlington (i.e., the hottest 5% of areas in Arlington, as determined by the Metropolitan Area Planning Council's published analysis).

¹⁰⁰ The Committee emphasizes that its discussions did not concentrate on any particular field or project. Any field in Arlington that is already artificial turf (like the Arlington Catholic High School field) or is far along in the planning and development stage (such as the new Arlington High School fields) was not a focus of this Committee's work or discussion. This Committee's findings and recommendations should inform future development at those fields when the time comes for the artificial turf fields at those locations to be replaced.

- When the Town of Arlington considers renovations of its fields, whether as natural grass or artificial turf, it should examine equitable access to high quality playing surfaces and balance the needs of different neighborhoods in that planning process.
- There should be no purchase of an artificial turf field until the Town of Arlington contractually mandates that the manufacturer will take full responsibility for ensuring that the materials will be recycled in the most environmentally sensitive manner possible at the end of the product's life.

The Committee wishes to emphasize that every future field development project in Arlington should be evaluated on a case-by-case basis, keeping the recommendations of this report in mind when doing so.

Regardless of whether Arlington builds any artificial turf fields in the future, the Committee feels strongly that all of Arlington's fields (artificial and natural turf alike) require high-quality maintenance programs. No future field should be developed (or re-developed) in Arlington without the costs of those high-quality maintenance programs being fully factored into the financial analysis for those projects. Even if Arlington never constructs another artificial turf field, it is absolutely essential that the Town maintain its existing natural turf fields to a higher standard than it has been doing in the past, which includes proper resting of the fields.

The Committee wants what is best for Arlington's field users, especially its youngest: healthy, well maintained playing fields that allow maximal use, enjoyment, and safety. Like any manufactured product of the modern age, artificial turf has its strengths and weaknesses. The Committee is now quite familiar with both. In the final analysis, the Committee believes that artificial turf fields can be an option for Arlington's future field projects (a) after careful evaluation of the practicality and feasibility of natural turf options, and (b) with proper health and environmental safeguards in place.

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Appendices

RECREATION FACILITIES AND WETLANDS JURISDICTION



APPENDIX 2

MAINTENANCE FREQUENCY - SYNTHETIC SURFACE & NATURAL TURF

MAINTENANCE FREQUENCY – SYNTHETIC SURFACE

Operation	Task	JAN	FEB	Mar	APR	May	June	July	Aug	Sept	Oct	Nov	Dec
Operations	Brushing			4	4	4	4	4	4	4	4	4	
	Aeration			1			1		1			1	
	Infill re-distribution			12	12	12	12	12	12	12	12	12	
	Top Dressing (Localized)		1	1			1		1			1	
	Grooming		1	1	1	1	1	1	1	1	1	1	
	Magnet Sweep			1			1		1				1
	Surface sanitization			1			1		1				
	Marking out (If required)	2	2	2	2	2	2	2	2	2	2	2	2
	Seam inspection/Repairs	1	1	1	1	1	1	1	1	1	1	1	1
	Snow Plough/ Removal	1	1	1									1
	Revitalization			1			1					1	
	Top Dress			1					1				
	Leaf/Debris Removal							1	1		1	1	1

MAINTENANCE FREQUENCY– NATURAL TURF

Operation	Task	Mar	APR	May	June	July	Aug	Sept	Oct	Nov
Cultural Operations	Mowing	2	8	8	8	8	8	8	8	4
	De-Thatching			1				1		
	Marking out		4	8	8	8	8	8	8	4
	Top Dressing		1	1				1		
	Over - Seeding			1			1	1		1
	Core Aeration			1					1	
	Deep Tine Aeration									1
	Wetting Agents		1	1	1	1	1	1	1	
	Irrigation		20	20	20	30	30	30	20	10
Spray /Granular Applications	Insect Control (Organic)			1	1					
	Nutrition (Various)			1	1		1	1		1
End of Season Renovation	Over - Seeding							1		1
	Core Aeration							1		
	Top Dress							1		